Carbonate-hosted Zn-Pb-Ba-Ag-Cu Deposits in the Lower Carboniferous of Nova Scotia: The Irish Connection

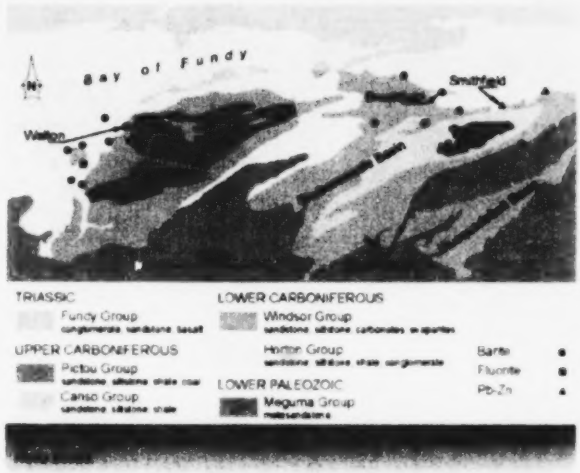
D. J. Kontak

Geological Setting

The Carboniferous stratigraphy of southern Nova Scotia is dominated by a thick (750 m) sequence of marine sediments of the Windsor Group, including evaporites, bituminous limestone, and carbonate mounds or reefs. Where these strata were infiltrated by high-temperature (ca. 250°C), saline (ca. 25 wt. % NaCl), metalliferous solutions, high-grade deposits of Zn, Pb, Ba, Ag and Cu were formed, including the Walton (4.4 Mt barite, 0.36 Mt sulphide ore with 4.0% Pb, 1.9% Zn, 0.7% Cu, 13.4 oz./t Ag produced) and Gays River (2.4 Mt: 8.6% Zn, 6.3% Pb reserve) deposits. Their style of mineralization, fluid chemistry and metal endowment are similar to Mississippi Valley Type (MVT) deposits and share many similarities with counterparts in the Carboniferous of Ireland.

Basal Carboniferous (Viséan) sedimentary rocks of the Kennetcook, Shubenacadie and Musquodoboit basins overlie either a deformed basement of metasandstones (Cambrian to Ordovician Meguma Group) or siliciclastics (Tournaisian Horton Group), with unconformable and conformable contacts, respectively. A marine incursion deposited: (1) laminated, bituminous, micritic limestone (Macumber Fm.; <3-18 m); and (2) shallow-water reef equivalents (Gays River Fm.; <40-50 m) which formed on paleotopographic highs. Overlying these basal carbonates is a thick sequence of evaporites and intercalated carbonates and shale. Younger terrestrial clastic rocks of Late Carboniferous to Permo-Triassic age, with minor volcanics, overlie the marine sequence. Structural complexities are variable and are especially evident in parts of the Kennetcook Basin.

Mineralization occurs: (1) occluding primary porosity, (2) as veins and fractures, and (3) as constant volume replacement of carbonate. In base-metal - rich deposits (Gays River, Smithfield) the mineralogy is generally simple with galena, Fe-poor sphalerite and trace amounts of calcite, barite, fluorite and Fe-Cu sulphides. The carbonate-evaporite contact is the locus of paleokarst zones, and breccia rock defines the hanging wall in parts of the deposits. In barite-rich deposits, mineralization associated with siderite is found in both the Horton Group (Brookfield) and Macumber Formation (Walton), and faults are more prominent than in the base-metal deposits.



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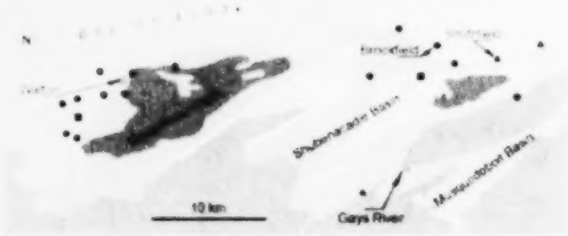

Figure 1. Regional geological setting of carbonate-hosted mineral deposits in southern Nova Scotia

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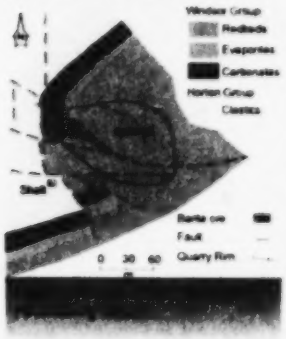
Gays River Deposit

At the Gays River deposit, the carbonate host rock formed as a reef complex on a paleotopographic high underlain by metasandstone of the Meguma Group. Mineralization resulted in replacement of dolomitized limestone where it was in contact with overlying evaporites. Mineralized zones vary from massive sulphide through net-textured ore to disseminated ore away from the hanging wall contact, and the Pb:Zn ratio increases basinward. The ore consists of Fe-poor, fine-grained, beige sphalerite and Ag-poor, medium-grained galena with minor to trace amounts of late-stage calcite, chalcopyrite, barite and fluorite. Mineralization occurred ca. 300 Ma, some 30 million years after deposition of the host rock carbonate, as a result of infiltration of high-temperature, highly saline fluids. Reduced sulphur originated from thermal chemical sulphate reduction of evaporitic sulphur due to the presence of sour gas in the carbonate bank. Isotopes of Pb (galena) and Sr (calcite, sphalerite) indicate a basement source (Meguma Group) or its detrital equivalent (Horton Group) for the metals.



Walton Deposit

At the Walton deposit stratabound ore replaces sideritized Macumber Formation limestone that is caught up in a fault-bounded drag fold. Near surface, the ore consists of barite and is overlain by evaporites, whereas at depth the barite ore contains sulphide lenses (Pb, Zn, Cu, Ag) with a hanging wall of redbeds and local karstic breccia. Deep drilling indicates that beneath the 1650' level the stratigraphy is overturned, possibly due to thrusting. Mineralization, of epigenetic origin but poorly constrained in terms of absolute timing, resulted from infiltration of high-temperature, highly saline fluids. The presence of abundant liquid petroleum - preserved as fluid inclusions in barite, of hydrothermal origin (i.e., 100-300°C) and derived from the organic-rich Horton Group strata underlying the area - probably promoted reduction of evaporitic sulphur to cause the sulphide mineralization.

Comparison to MVT and Irish Deposits

The carbonate-replacement deposits of southern Nova Scotia share many similarities with MVT deposits in terms of host rocks, metal endowment and fluid chemistry. In addition, there are many similarities with the large Irish-type carbonate deposits (e.g., Silvermines, Navan) with respect to mineralalogy (Zn, Pb, Ba; Fe-poor), presence of dolomitization and sideritization, ore textures (replacement) and fluid chemistry. Perhaps the faults at Walton represent re-activation of feeder faults for mineralizing fluids that are so prevalent in the Irish deposits. The major difference between the two areas appears to be the relative timing of mineralization, which was late in terms of diagenesis and burial in the Nova Scotia deposits, but which coincided with diagenesis and burial in the Irish deposits.

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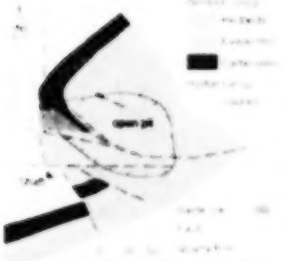

Figure 1. Geology of the Walton barite-Pb-Zn-Cu-Ag deposit.

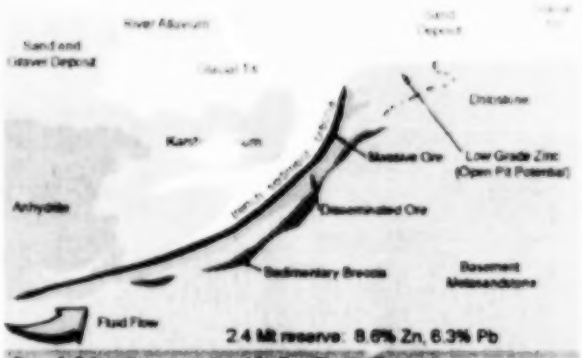

Figure 2. Schematic cross-section of the Gays River Zn-Pb deposit.

At the Walton deposit stratabound ore replaces sideritized Macumber Formation limestone that is caught up in a fault-bounded drag fold. Near surface, the ore consists of barite and is overlain by evaporites, whereas at depth the barite ore contains sulphide lenses (Pb, Zn, Cu, Ag) with a hanging wall of redbeds and local karstic breccia. Deep drilling indicates that beneath the 1650' level the stratigraphy is overturned, possibly due to thrusting. Mineralization, of epigenetic origin but poorly constrained in terms of absolute timing, resulted from infiltration of high-temperature, highly saline fluids. The presence of abundant liquid petroleum - preserved as fluid inclusions in barite, of hydrothermal origin (i.e., 100-300°C) and derived from the organic-rich Horton Group strata underlying the area - probably promoted reduction of evaporitic sulphur to cause the sulphide mineralization.

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